

US Army Engineer Research and Development Center

**Coastal and Hydraulics and
Environmental Laboratories**

Currituck Sound Hydrodynamic and Water Quality Study



**US Army Corps
of Engineers®**

Part 1: Hydrodynamic Modeling



Hydrodynamic Modeling

- **ADCIRC Grid Development/Refinement and Calibration**
- **CH3D Grid Development and Calibration**
- **ADCIRC - CH3D - ICM Linkage**
- **ICM Volume Conservation**
- **ADCIRC - CH3D Model Improvements**
- **2006 Model Calibration**
- **On Going Model Simulations and Scenarios**
- **Looking Forward**



Currituck Sound and Surrounding Water Bodies



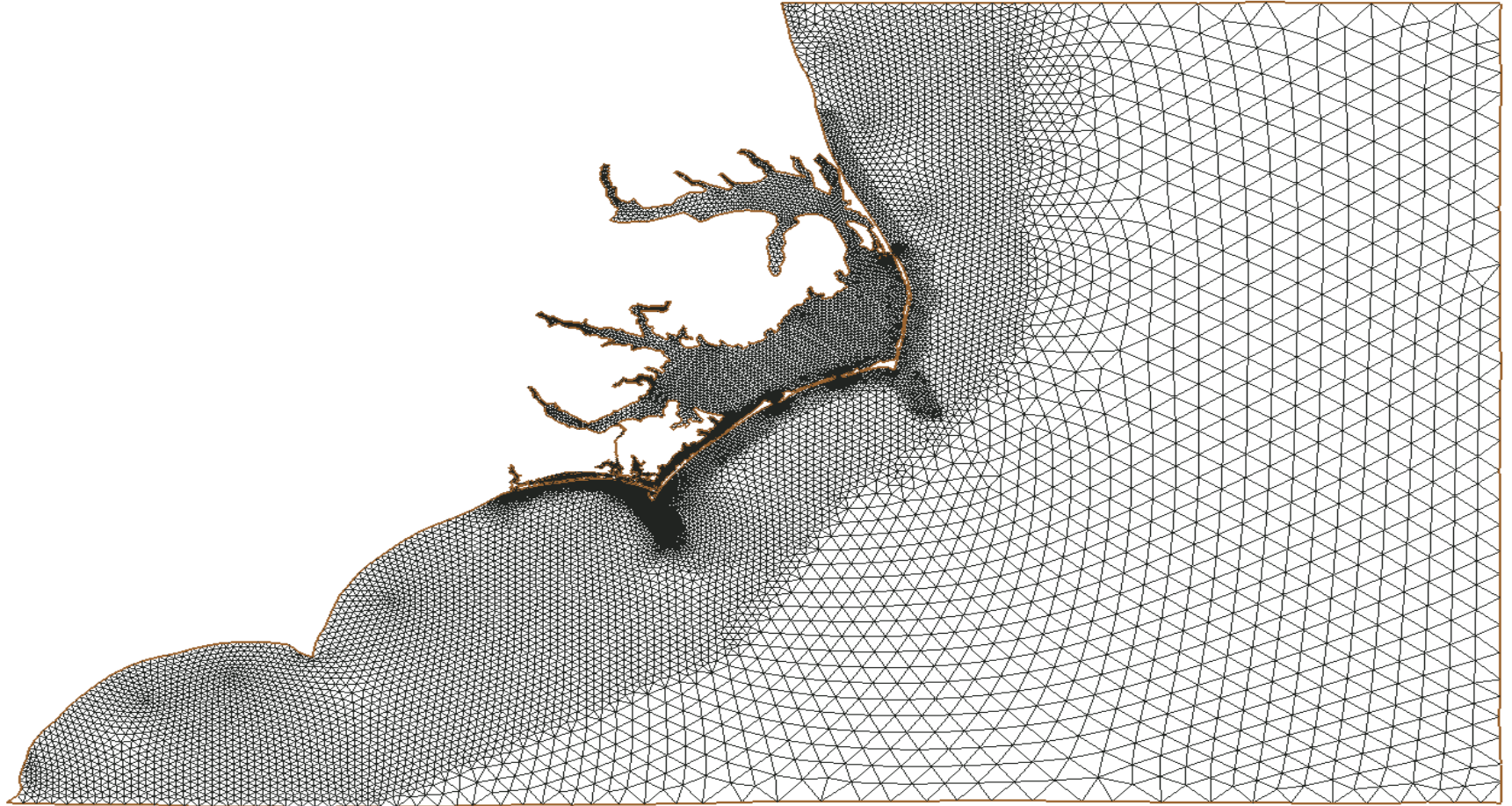


ADCIRC Reminement and Calibration

- **Long-wave, Finite Element, Hydrodynamic Model**
- **Existing Beaufort Inlet (Rick Luettich, UNC Morehead City)**
- **Additional resolution and representation of the bathymetry, mud-flats, shoreline and tributaries**
- **Selected two test events: May and July- August 1998**
- **Developed tide, wind and tributary flow input files**
- **Model Calibration: July-August 1998**
- **Model Verification: May 1998**

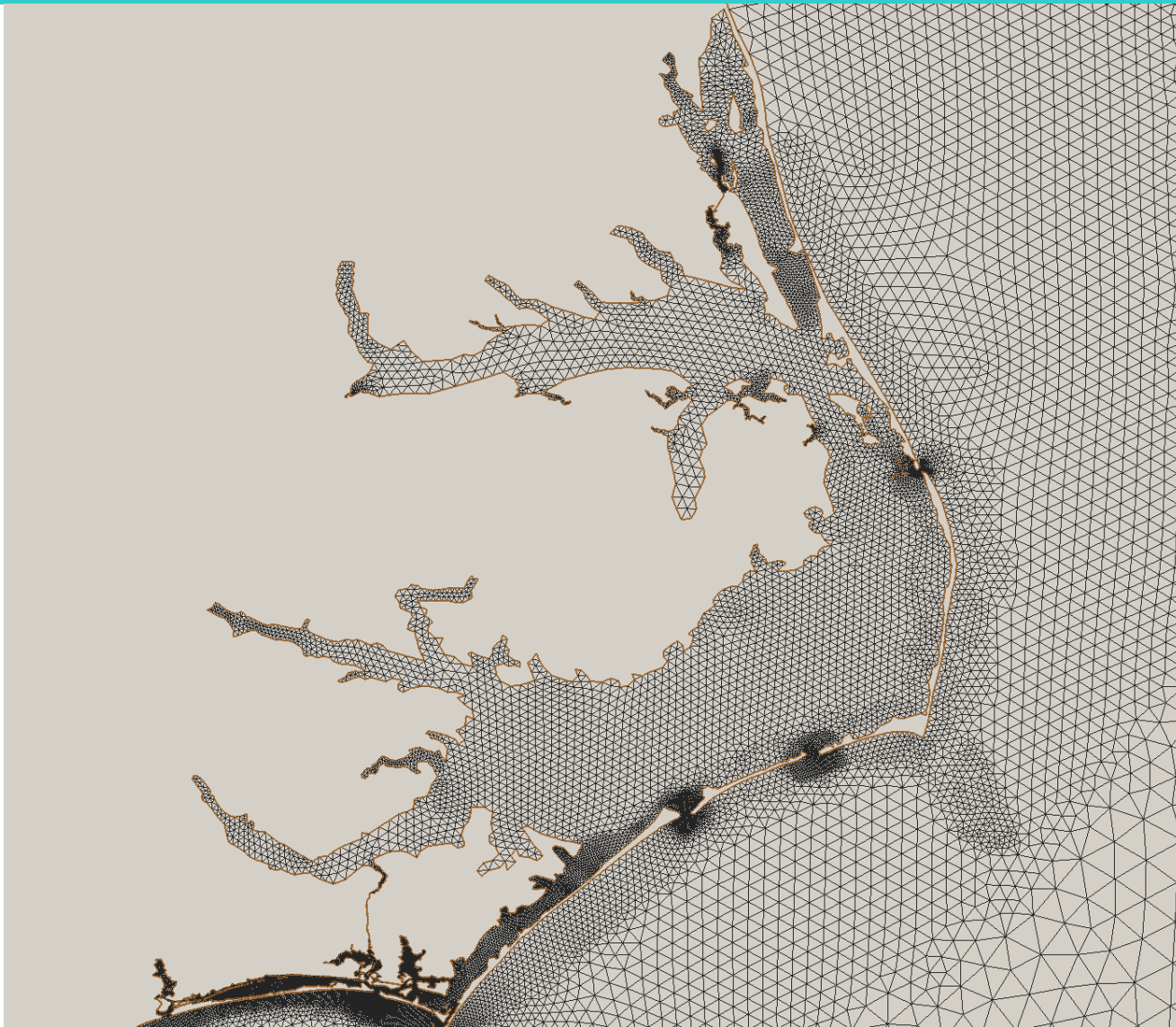


Regional Grid



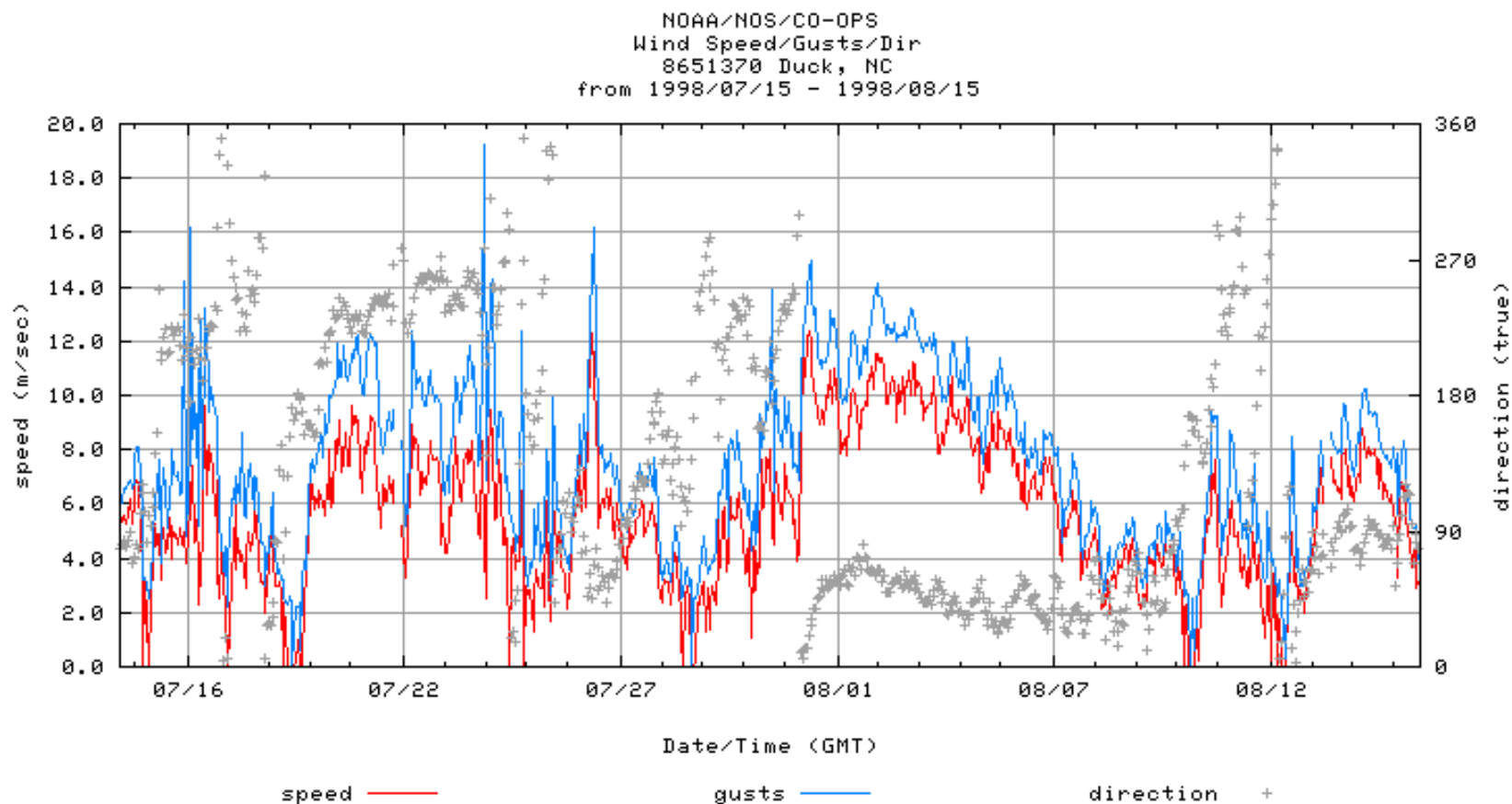


Pamlico/Albemarle/Currituck Sound Grid





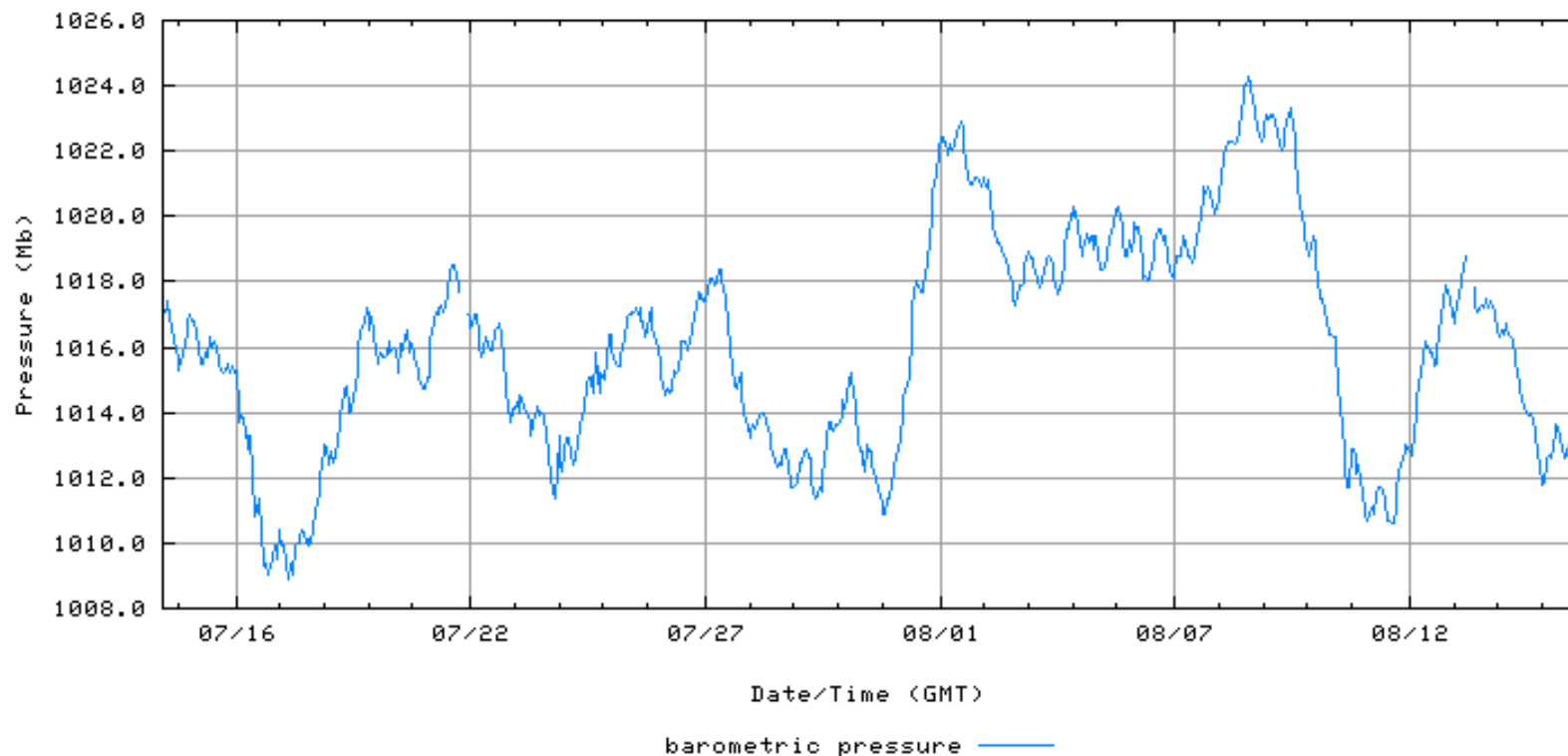
July - August 1998 Event





July - August 1998 Event

NOAA/NOS/CO-OPS
Barometric Pressure Plot
8651370 Duck, NC
from 1998/07/15 - 1998/08/15





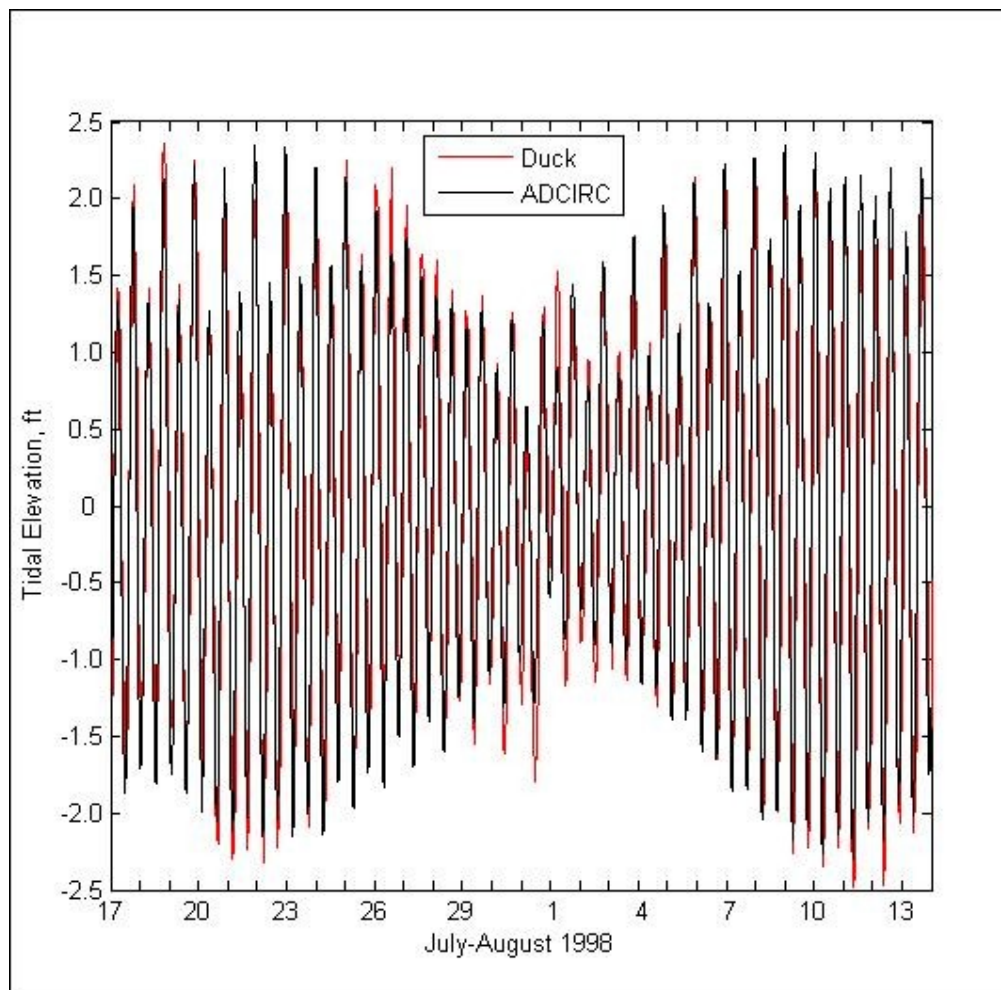
ADCIRC

Calibration/Verification Sites



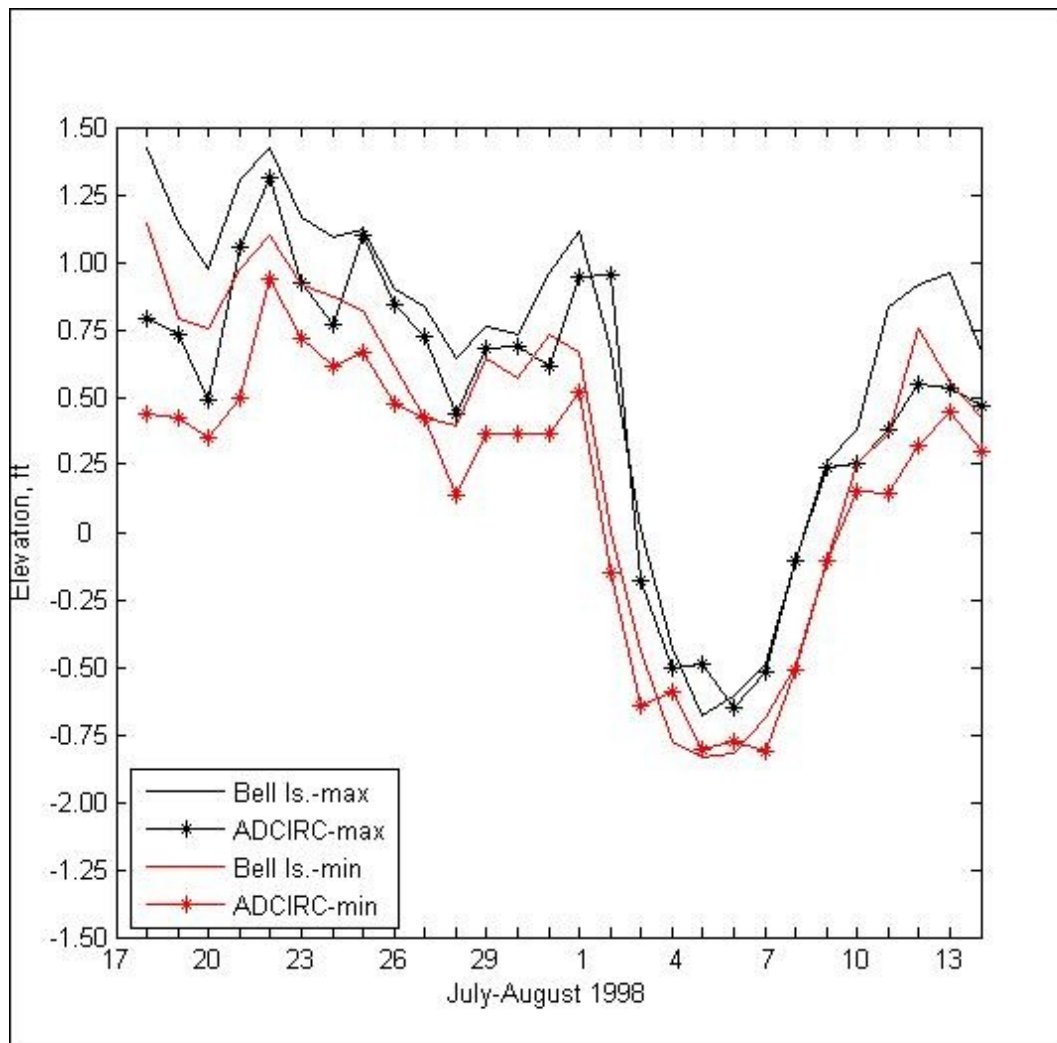


Tide Calibration: Duck (FRF)



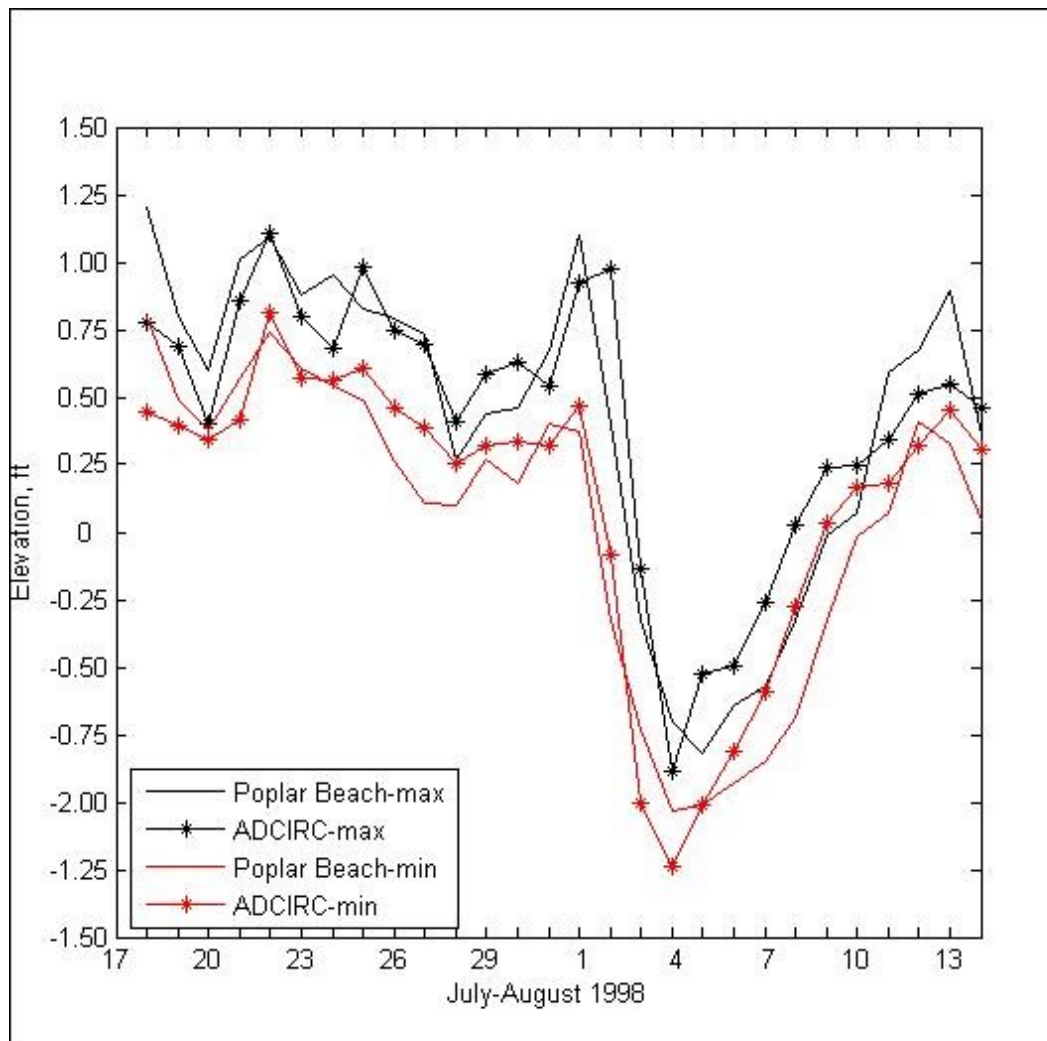


Tide Calibration: Bell Island



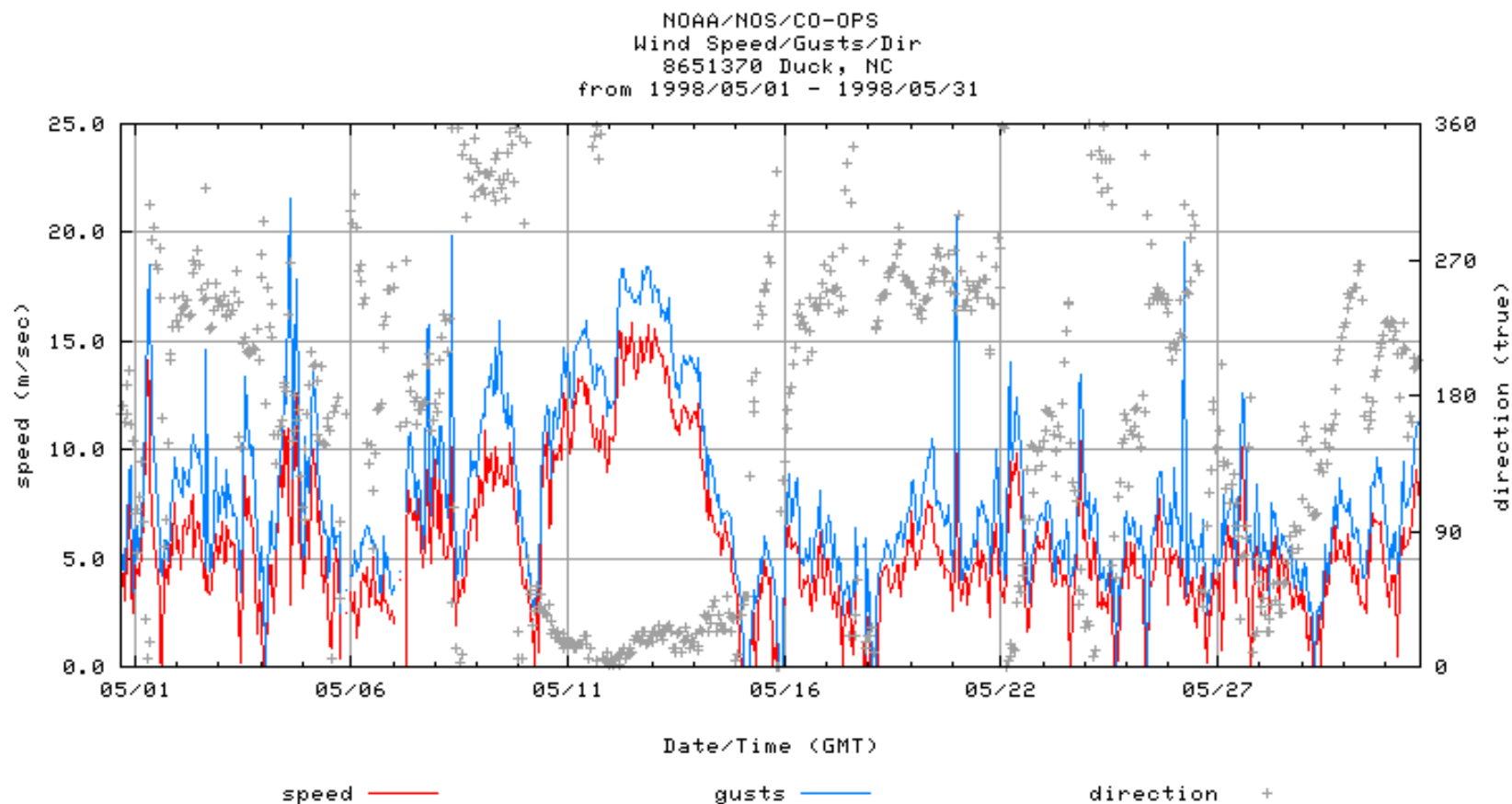


Tide Calibration: Poplar Beach





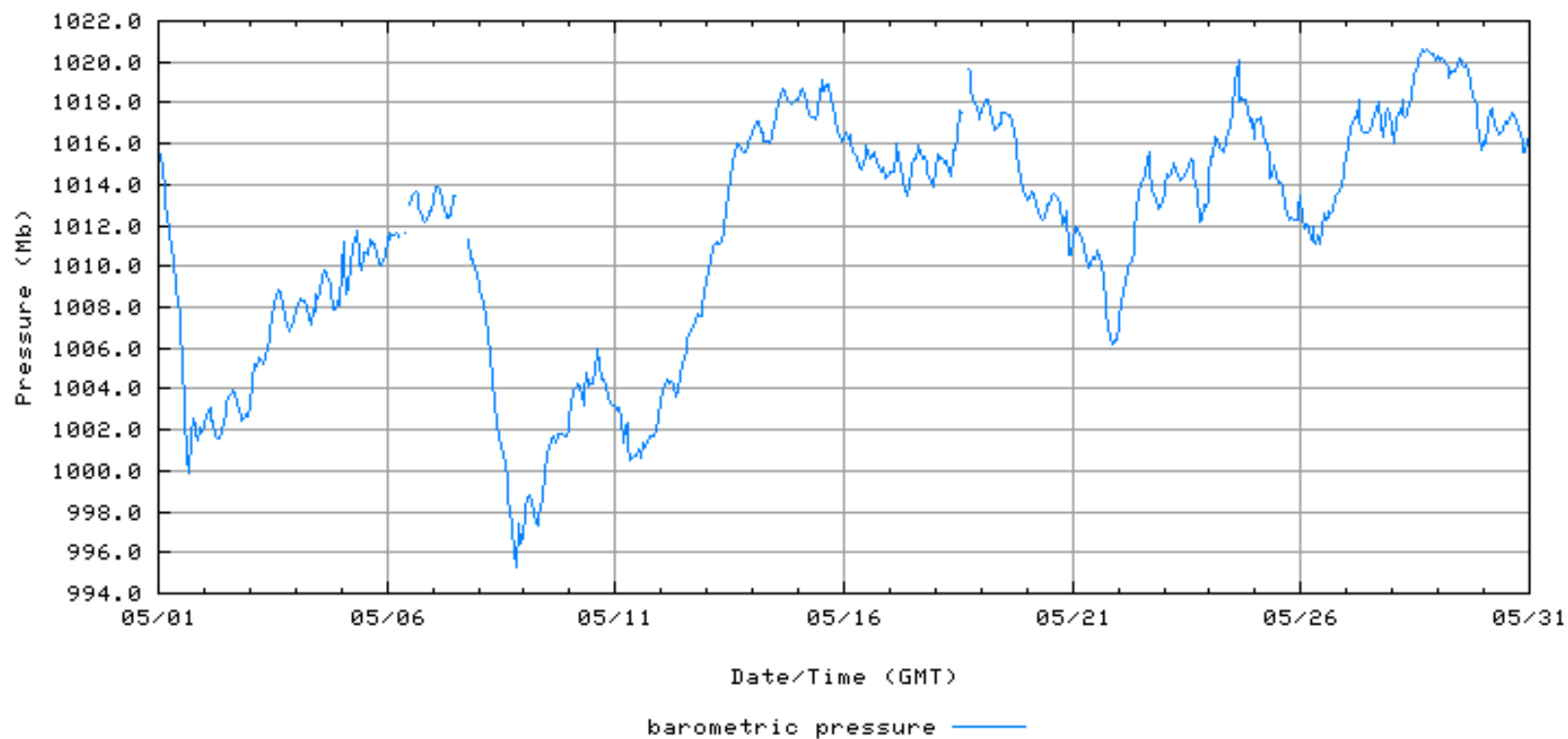
May 1998 Verification Event





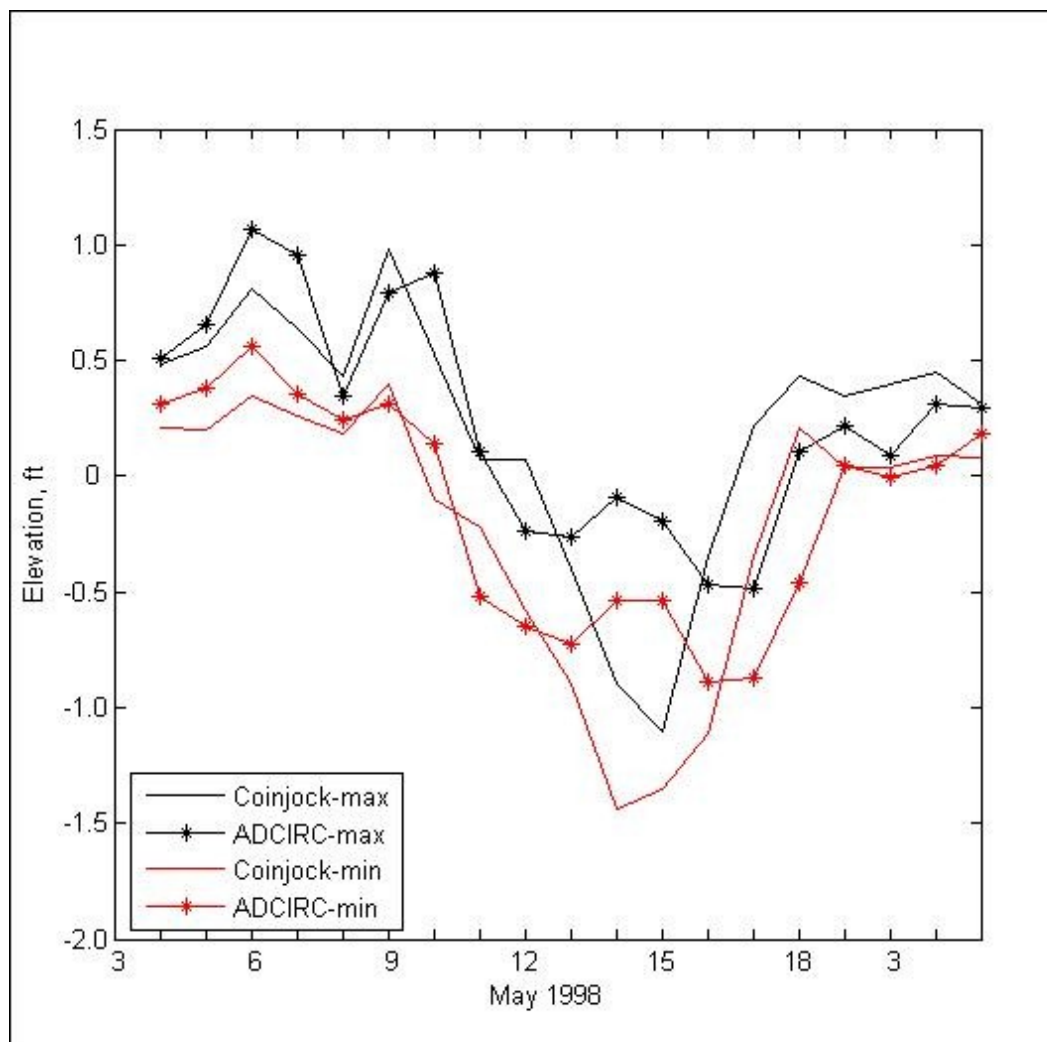
May 1998 Event

NOAA/NOS/CO-OPS
Barometric Pressure Plot
8651370 Duck, NC
from 1998/05/01 - 1998/05/30





May 1998 Verification: Coinjock Canal





CH3D

- **3D Structured, Boundary-Fitted, Regional Hydrodynamic Model**
- **Sigma and Z-Grid Versions**
- **Baroclinic Salinity and Thermal Transport**
- **Recent Improvements**
 - **Spatially Variable Wind and Radiation Stress Gradient Forcing**
 - **Volume and Mass Conservative Wetting and Drying**
 - **Multi-Block Parallel Processing**



ADCIRC - CH3D - ICM Linkage

- **CH3D Grid Developed Using ADCIRC Shoreline and Bathymetry within the Sounds**
- **CH3D Linkage Utilities Utilize The Regional ADCIRC Simulation Results and Provides Water Surface and Flow BC's to The Local or Refined CH3D Grid**
- **Tide and Wind Influenced Water Surface Elevations Are Specified At The CH3D Boundaries at Oregon Inlet and Northern Pamlico Sound**
- **CH3D Simulations Provide Geometry and Volume Conserving Hydrodynamics to ICM**



ADCIRC - CH3D IMPROVEMENTS

- **Upgraded Bathymetry (Captain Barry Cullens)**
- **Modified Buoy Wind Algorithms**
- **ADCIRC-CH3D Calibration April 2006**



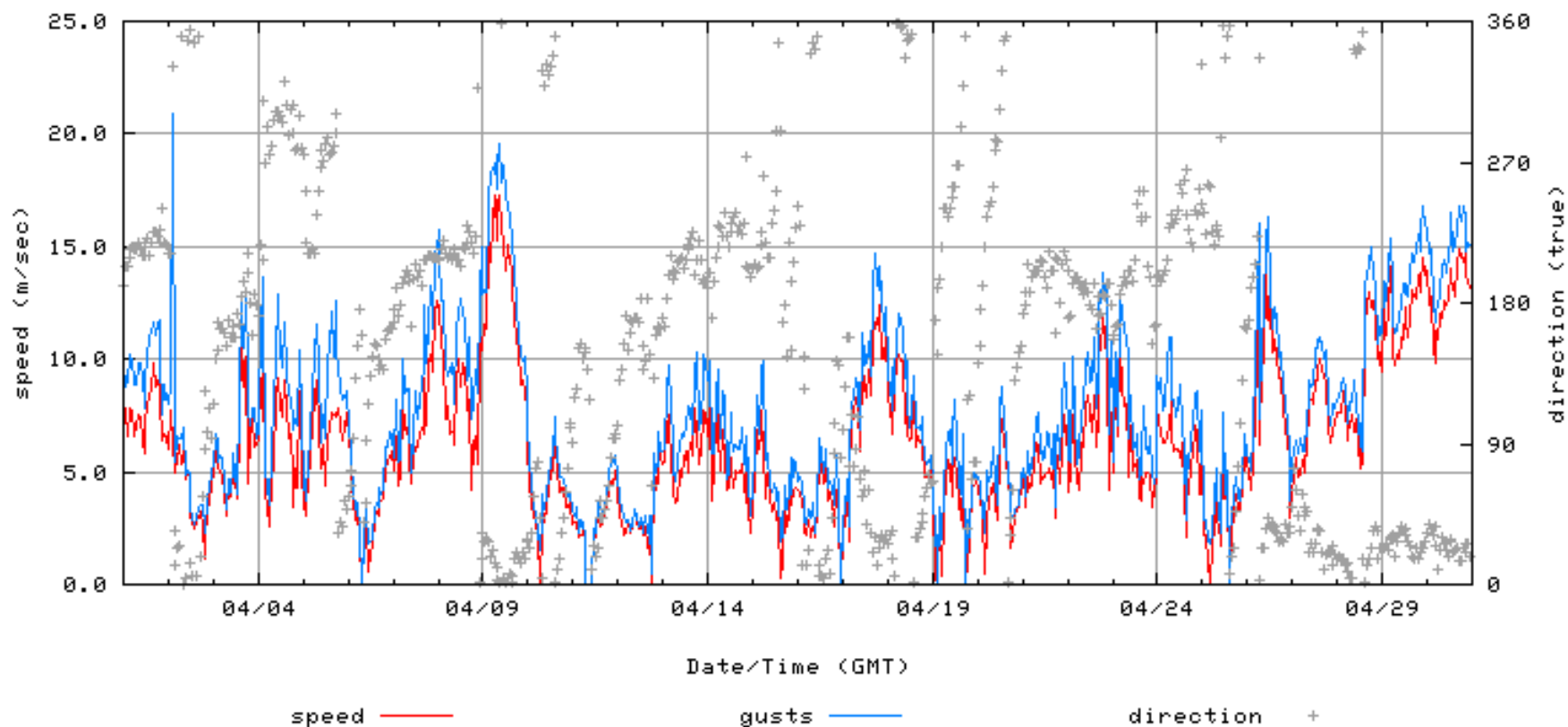
CH3D - ICM Grid





April 2006 Model Calibration Period

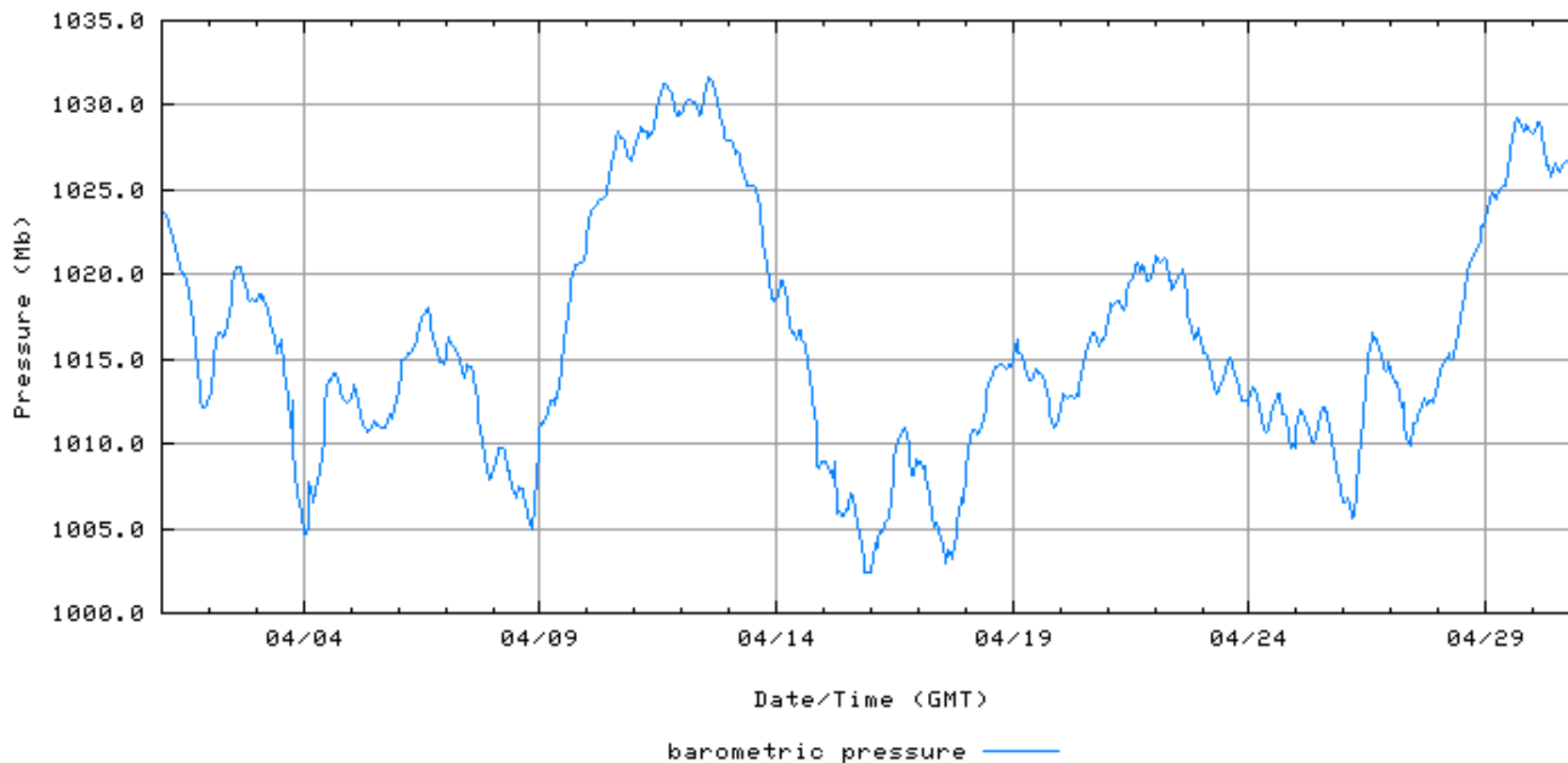
NOAA/NOS/CO-OPS
Wind Speed/Gusts/Dir
8651370 Duck, NC
from 2006/04/01 - 2006/04/30





April 2006 Model Calibration Period

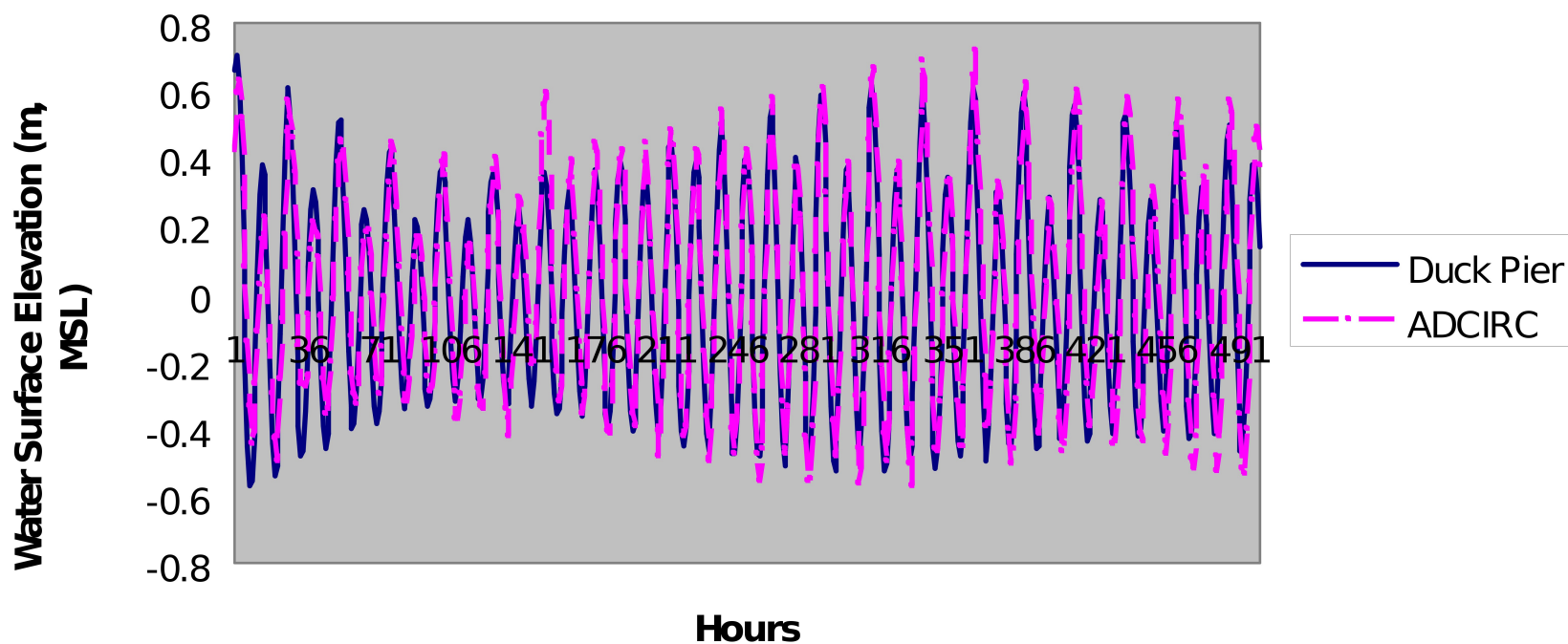
NOAA/NOS/CO-OPS
Barometric Pressure Plot
8651370 Duck, NC
from 2006/04/01 - 2006/04/30





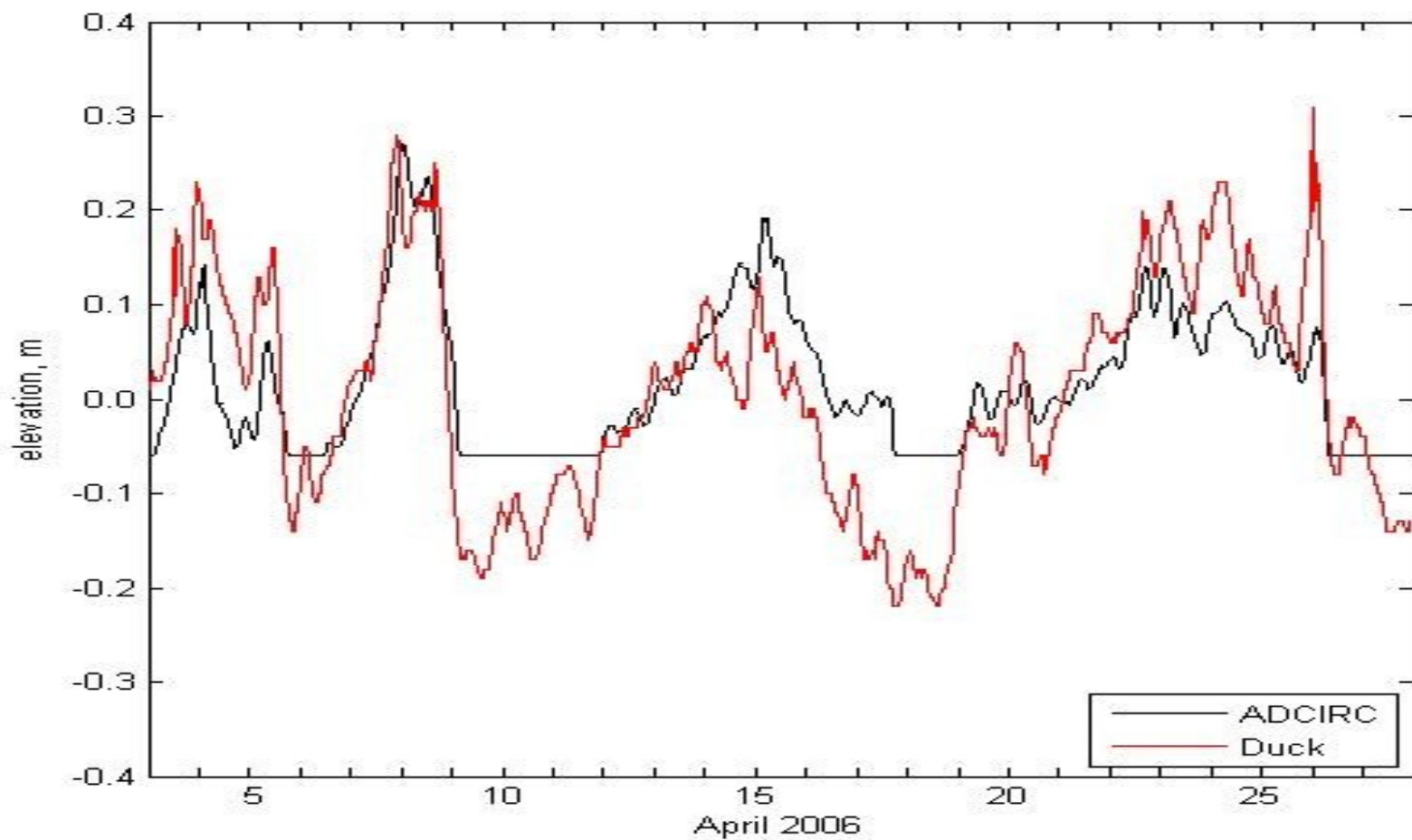
April 2006 Model Calibration Period

Duck Pier ADCIRC Comparison



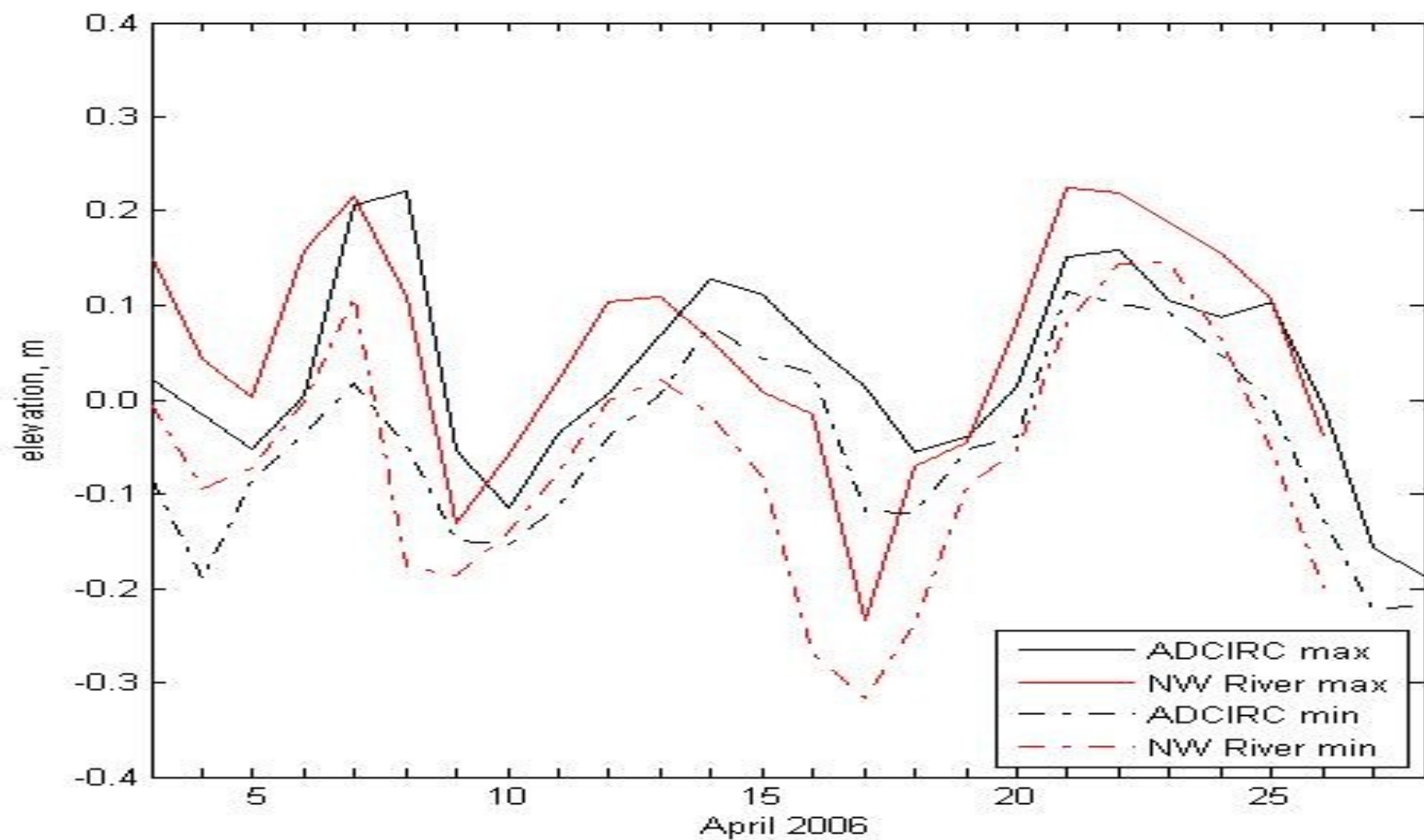


ADCIRC Duck-CS Comparison



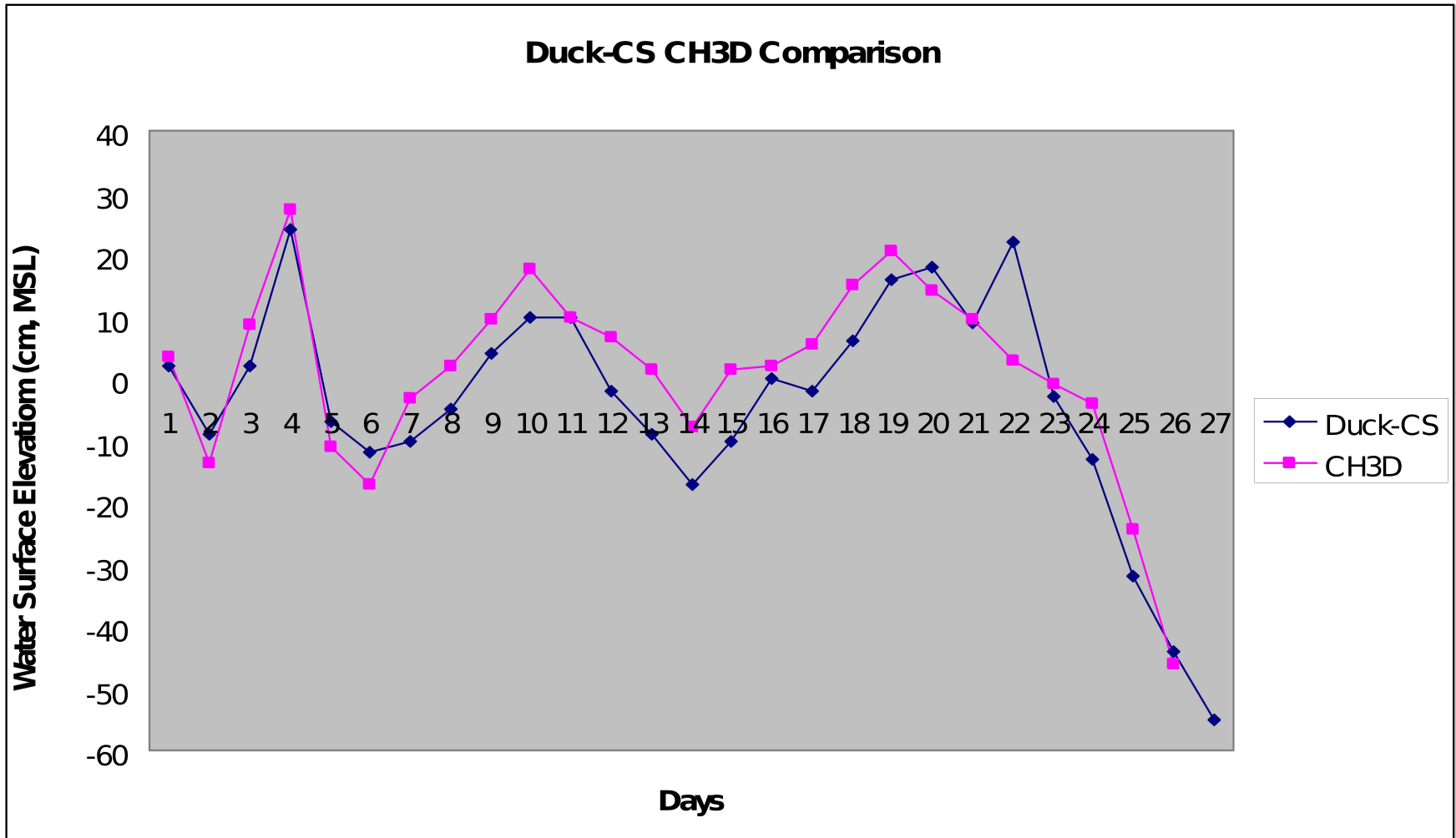


ADCIRC NW River Comparison



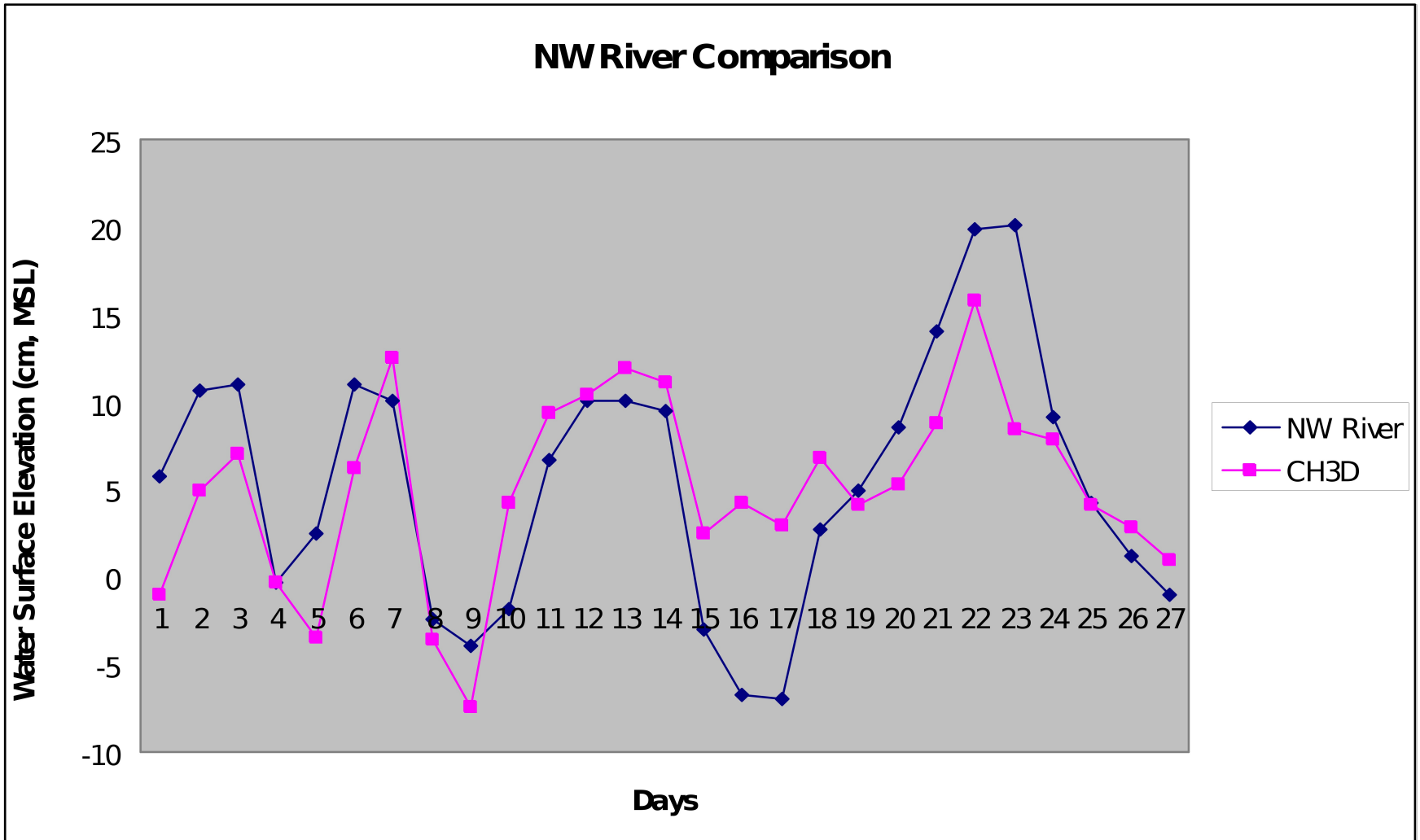


CH3D Duck-CS Comparison





CH3D NW River Comparison





Summary

- Modeling Package Contains Demonstrated Technology
- Hydrodynamic Components Capable of Capturing significant processes impacting circulation
- ADCIRC - CH3D- ICM linked
- Mass and Volume Conservation Demonstrated in ICM



On Going Model Simulations/ Scenarios

- **Watershed Inputs Developed by USGS and SAW**
- **Hydrodynamic Scenario Simulations**

**Scenarios Based Upon the 2006-2007 Field
Measurement Time Period**

Back Bay Saltwater Pumping

Roanoke River 1940 Flood Event

Roanoke River 2006-2007 Regulated Flows

Roanoke River 2006-2007 Unregulated Flows



Moving Forward

- **Investigate the Impact of Suspended Solids on Light Extinction**
- **Resuspension Due to Combined Current and Wave Shear Stress**
- **Analytical or STWAVE Wave Predictions**
- **SEDFLUME Analysis for SEDZLJ Erosion Rates**
- **STWAVE-ADCIRC-CH3D-SEDZLJ-ICM Linkage**



SEDZLJ

- CH3D predicts water elevation and velocity at each grid cell for each time step
- STWAVE predicts wave height, period, direction
- SEDZLJ combines wave, current and water depth conditions to estimate shear stress on the sediment bed at each cell in the CH3D domain
- SEDZLJ calculates erosion, deposition, concentration, and transport for each time step at each CH3D cell
- SEDZLJ output includes bed elevation change, concentration, and composition (sand, silt, clay)

